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ABSTRACT

This paper relates experiences in implementing a peer-assisted study program in a teacher education course. A class of 124 students in their first year of a Bachelor of Education (Early Childhood Program) undertaking a core course in basic science were the subjects of the study. They were mentored in a peer-assisted learning program by eight third year students, who themselves, had done the same core course in their first year. Firstly the study examined the impact of the initiative on the students in the core course in terms of their achievement grades and their changes in attitudes toward science and science teaching. Their performance in a subsequent Science Education course was then monitored. The study further explored tutors' reasons for becoming involved in the initiative, their experiences, and the consequences of tutors' involvement in the program. The quantitative findings indicate that those first year students who participated in the peer-assisted learning program achieved higher grades than those who did not. The qualitative data reveal that students develop confidence and improved attitudes toward learning and science. In addition, substantial benefits in terms of confidence, facilitation skills, and insight into adult education were accrued by the mentors. (Contains 28 references.) (Author/SLD)

Peer assisted learning: Impact on self-efficacy and achievement

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Abstract

This paper relates experiences in implementing a peer-assisted study program in a teacher education course. A class of 124 students in their first year of a Bachelor of Education (Early Childhood program) undertaking a core course in basic science were the subjects of the study. They were mentored in a peer assisted learning program by eight third year students, who themselves, had done the same core course in their first year. Firstly the study examined the impact of the initiative on the students in the core course in terms of their achievement grades; their changes in attitudes to science and science teaching; and monitored their performances in a subsequent Science Education course. Secondly, the study explored tutors' reasons for becoming involved in the initiative; and the experiences and consequences of the tutors' involvement in the program are reported. The quantitative findings indicate that those first year students who participated in the peer assisted learning program achieved higher grades than those who did not. The qualitative data revealed that students develop confidence and improved attitudes to learning and science. Additionally, substantial benefits in terms of confidence, facilitatory skills and insight into adult education were accrued by the mentors.

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Theoretical framework

Theories that attempt to explain student persistence and achievement in undergraduate courses are varied and focus on a number of factors. Some highlight individuals and their personal characteristics, situations and motivations. Others emphasize the maturation of students into a University environment and the nature of support provided by the institution. No theory provides total insight into the problem of student persistence. A common element in many theories is the conscious decision of students to behave in a particular way in response to situational feedback.

Achievement in any intellectual endeavor depends on a cognitive and an affective dimension. Conceptual and procedural knowledge provide the structures for understanding and working successfully in a particular cognitive domain or field of enterprise but just as important is the motivational aspect which influences an individual's approach to learning.

Three discrete components contribute to motivation to achieve: *values*, *expectancy* and *affect*. A task is valued because of the need to meet intrinsic or extrinsic goals (Covington, 1993; Dweck & Leggett, 1988). It also may be undertaken because of some value associated with the endeavor. For example, if one believes that a knowledge of science is important socially, one values the task of teaching science, will attempt to learn it and feels obligated to teach it well.

A prominent place in the explanation of human behaviour is expectancy, which is influenced by beliefs about the extent to which a person is in control of his or her own destiny and judgments of those beliefs. People behave resignedly because they acquire expectancies that they cannot affect environmental outcomes through their actions (Rotter, 1966). In general, a person who attributes success or failure to external events and thus has an external locus-of-control is less active in pursuing challenging tasks. Self-referent expectancy systems also regulate behaviour. A person holds beliefs about his or her ability to engage in particular activities and the likely outcome of such engagement, i.e. self-efficacy beliefs. Self-efficacy beliefs are born out of successful or unsuccessful antecedent experiences (Bandura, 1986). Preservice teachers who are expected to engage in teaching science in primary school may hold low self-efficacy beliefs about their ability to teach science after graduation (Watters, Ginns, Enochs & Asoko, 1995; Ginns, Watters, Tulip, Lucas, 1995; Ginns & Watters, 1996). This sense of self-efficacy mitigates against students engaging effectively in learning science. Bandura's (1986) self-efficacy model has provided the most significant insights into the general behaviour of teachers (Ashton & Webb, 1986; Dembo & Gibson, 1985; Greenwood, Olejnik & Parkay, 1990). Therefore, self-efficacy should be an important consideration in the preservice preparation and induction of new teachers.

Affect refers to a wide range of phenomena including feelings, emotions, moods and drives. The emotional aspect manifested in fear, joy, anger, anxiety can have physiological origins with concomitant interruptions of the attentional mechanism of the human nervous system and produce interfering demands on cognitive processing (Simon, 1982). In contrast, moods may be beneficial to task commitment as sadness or happiness may influence cognitive functioning and associate these feelings with particular endeavors. Another aspect of affect relates to feelings of self-esteem, self-image, or self-concept. In competitive, individualistic societies, where one person's success is another's failure, social comparison enters inevitably into self-appraisal. In maintaining public approval a person may choose to minimize investment of energy into risky enterprises.

Thus motivation is a multifaceted construct influenced by previous history of the student and his or her personal self-regulatory mechanisms. Although students engage in self-observation, self-judgment and self-reaction, the benchmarks against which decisions are made are socially experienced (Bandura, 1986). Thus, contributing to the integration of the motivational components is the context in which learning occurs. Motivation, conceptual knowledge, procedural knowledge develop within a culture manifested through a community of practice. Such communities are bound by intricate, socially constructed webs of beliefs, which are essential to the development of a world view, an ideal or a common purpose. Undergraduate teaching and learning occurs all too often without the support of this culture of practice. Students are expected to be developing intellectual skills and practices that inculcate them into their chosen profession. On graduation we expect them to be competent albeit neophyte practitioners. To the extent that this is successfully achieved

probably depends on many factors not least of which is the opportunity to engage in authentic practice. For example, preservice teachers undertake regular subjects involving practice teaching. Many others of their own volition seek employment or volunteer to work in educational settings such as after-school care. These experiences allow for the integration of theory with practice and contribute to the development of a vision of what it means to be a practitioner.

In contrast, first year undergraduate students have not become engaged in the authentic practice of their profession. They carry with them the baggage of high school learning with preconceived ideas and images of what their professional development entails. Thus, they are confronted with the learning of science for the purpose of teaching science, whereas in school, science formed part of the curriculum, was taught as a body of knowledge without grounding in any authentic activities, and was studied as a means to an end, namely, passing the exam. Opportunities to engage in negotiations with credible peers and experts leads to the construction of a purposeful culture and set of practices. These coherent, meaningful and purposeful activities are authentic in that they define the practices that successful practitioners have adopted (Brown, Collins & Duguid, 1989).

Background to this study

In the elementary grades, teachers are generalists with responsibilities to teach across a range of knowledge domains or key learning areas including science. Hence in preservice education programs characteristic of the type offered at the university where this study was conducted, science education is a core component for elementary and early childhood teachers. Students are required to complete a Foundation Science course in which they gain some insights into general science and then to complete a Science Education course that concentrates on learning and teaching science. Most students have had limited experience with science prior to enrollment in the Foundation Science course and consequently many express high levels of anxiety. The course attempts to provide a basic introduction to those concepts, particularly in the physical sciences, which underpin many of the activities that young children would experience in school settings. The Foundation Science course is seen to be challenging and difficult for many students and has a high failure rate.

A number of initiatives designed to enhance student achievement and attitudes towards science have been explored previously with limited positive outcomes. These were built around counseling techniques that included rational emotive therapy, relaxation therapy, and development of self concept (Watters, Ginns, Neumann, & Schweitzer, 1994). An analysis of these initiatives suggested that collaborative group work and the formation of self-help discussion groups were effective interventions. Thus, a normalization and extension of a collaborative group work approach for a subsequent cohort of students was envisaged as a worthwhile initiative, hence the decision to implement a peer assisted learning program. Peer teaching has long been held to be an effective means of teaching at tertiary level and a meaningful approach to learning as professionals frequently need to collaborate with other professionals in order to solve problems (Abercrombie, 1974). A number of models have been proposed (Goodlad & Hirst, 1989; Topping, 1988) but for reasons of convenience and availability of support the following model was implemented.

The Peer Assisted Study Sessions (PASS) program is a teaching and learning initiative designed to assist participating students to acquire, more readily, relevant content knowledge and master essential academic and study skills. PASS is modeled on the Supplemental Instruction (SI) program, a non-remedial, institution-wide approach to enhancing student performance and retention, developed at the University of Missouri-Kansas City (Blanc, DeBuhr & Martin, 1983). The implementation of PASS used strategies consistent with the philosophy of SI but local usage of the acronym reflected the emphasis on peer assistance rather than instruction and hence this terminology has been adopted in this study.

PASS is voluntary and targets 'at risk' courses, those that are consistently difficult for students and consequently, have high failure rates. PASS leaders are all students who have had prior successful experiences in the 'at risk' subject and, after training, manage the group sessions or workshops.

The implementation of PASS reported in this paper was part of a University-wide initiative to support students in courses at risk. The leaders were prepared and trained by staff accredited by the University of Missouri-Kansas as Supplemental Instructor Leaders. Training occurred on two days separated by

approximately four weeks. The second day occurred after the program had commenced. When the program was implemented the PASS leaders worked either singly or in pairs with volunteer students. Congruent with the key features of SI, the leaders attempted to set up collaborative learning environments that focused on integrating the *how* and *what* to learn by creating productive interaction between students. In this study the leaders were students in the third year of their program and received financial remuneration for their involvement.

Research into the effectiveness of SI has produced some interesting and encouraging results over the past decade. Wolfe (1987) showed that even when the control group had higher SAT scores the SI group out-performed them in the achievement of final grades. In a control-experimental group study of students Kenney (1989) also found that the grade point average of the experimental group who participated in a SI intervention (defined as 60% attendance) was significantly higher than the grade point average of the control group. Kenney specifically concluded that students who received the SI treatment out-performed their control group colleagues due to the beneficial effects of SI and not to the increased exposure of the group to course material. Similar positive results have been reported in more recent studies (Congos & Schoeps, 1993; Martin & Arendale, 1994; Zaritsky, 1994).

Given that participation in SI is voluntary, questions still persist as to the characteristics and motivations of those students who choose to participate. These questions were partly addressed by Visor, Johnson and Cole (1992) who explored locus-of-control, self-efficacy and self-esteem of participating students. They found that regular participants were marginally more internally oriented and had higher self-efficacy. There has been little research on the role that the leaders play in SI, its impact on them as learners and the strengths and characteristics necessary for leadership. Congos and Schoeps (1993) suggest that leaders require skills in interpersonal relations along with leadership, counseling and teaching abilities.

A focus of the PASS intervention was explicitly on developing students' confidence and reducing their anxiety about science. The training and preparation of the leaders drew implicitly on issues related to establishing effective learning environments built on constructivist principles and employing strategies associated with cognitive apprenticeship (Collins, Brown, & Newman, 1989).

The objectives of this study were to explore the impact of an initiative involving peer assisted study sessions (PASS) on undergraduate student achievement and confidence in their ability to teach science. In particular this paper explores three questions: (a) Do students who participate in peer assisted learning based on the PASS model achieve higher course grades? (b) Is self-efficacy a factor related to participation in the program by students and if so how does self efficacy of students change as a consequence of involvement in the program? (c) What impact does the program have on PASS leaders?

Methods, Techniques and Data collection

The research design involved the collection of both quantitative and qualitative data. The subjects of the study were 124 undergraduate Bachelor of Education (Early Childhood) students enrolled in a first year Foundation Science course, which has been detailed above and eight third year undergraduate students previously enrolled in the same course identified in this paper as the PASS leaders. Students were surveyed at the commencement of the semester with a Science Teaching Self Efficacy Belief Instrument (STEBI-B) (Enochs & Riggs, 1990), which has been trialed and validated on similar populations (Ginns, Watters, Tulip, & Lucas, 1995). This instrument provides a measure of the student's personal science teaching self-efficacy (PSTE). They were then retested with the STEBI-B at the end of the semester and at the conclusion of the following semester. At the midpoint of the Foundation Science semester a sample of 19 students drawn from all students in the course was surveyed using an open-ended questionnaire to ascertain their attitudes to and beliefs about science and to comment on the PASS program.

The PASS intervention occurred during the Foundation Science course. Participation in the PASS program was voluntary and hence attendance varied from nil to 100%. For analysis students were blocked into groups that attended no PASS workshops, from 0-33%, 33%-66% and greater than 66%. Final grade scores were obtained from a compilation of mid-semester assessment items and end of semester examination results. During the following semester the students undertook a Science Education (curriculum methods)

course that focused on teaching methods for early childhood science. There was no PASS program supporting the methods course.

Selection of PASS leaders

PASS leaders were selected from students in the third year of their BEd (Primary) program. These students had already experienced Foundation Science and studied a Science Education course in which many principles of learning science were explored. Learning in this latter course focused on constructivist-inspired strategies such as collaborative learning, conceptual change through discourse, and the development of autonomy. It was considered that students who had successfully completed both courses represented a pool of partially trained candidates from which suitable PASS leaders could be selected. Initially, all students enrolled in the Science Education unit were invited to nominate themselves for selection as PASS leaders, if they were interested in the PASS program. Twenty three students responded to the invitation from which fourteen were selected for interview on the basis of high achievement in both Foundation Science and Science Education and possession of high levels of self-efficacy and positive attitudes to science measured by the use of psychometric tests as part of previous research on the Foundation Science course. Each candidate was interviewed for 15 minutes by the two researchers (JW; IG) involved in the Foundation Science unit. Assessments of the student's reasons for wanting to become a PASS leader, his or her ability to clearly and coherently describe strategies for professional and personal interaction with participants in PASS, his or her potential ability to diagnose and remediate problems of various kinds in PASS workshops, and professional and personal presentation, were used to determine the successful candidates from the interview process. Offers were forwarded to eight of the interviewed applicants to become PASS leaders in the Foundation Science unit for the first year Early Childhood strand. All eight (seven females and one male) accepted the offer and moved on the formal PASS training workshops as described previously.

Monitoring the role of PASS leaders and workshops

The PASS leaders maintained a journal, reported each week by email and met regularly with the researchers. Weekly reports comprised a synopsis of critical incidents and other anecdotal experiences, feelings and concerns of each of the leaders. In the regular meeting, leaders and the researchers shared strategies for dealing with issues. At the conclusion of the semester the leaders reflected on, and expressed their experiences in a narrative format. The PASS leaders were encouraged to be active participants in the program and to evaluate their participation by adopting a reflective, action research focus. Consequently the group devised their own evaluative survey the results of which are incorporated into this study. The qualitative data were analyzed for common themes.

The authenticity of implementation of the PASS workshops was verified by examination of field notes and diary entries made by a PASS Leader trainer who visited three sessions and noted the dynamics and management of the workshops.

Results

Implementation of and Participation in the PASS Program

Fifty nine out of the 124 students, who completed all requirements for the Foundation Science course, participated in the PASS program. Of these 59 students, 18 attended less than 33% of the available workshop sessions, and 25 attended more than 67% of the available workshop sessions.

The PASS leaders were encouraged to explore, with their group reasons for participating. The predominant reason given for participating was a need to "understand science." Students admitted an anxiety about doing science but were keen to obtain help in order to pass the course. The students who attended irregularly or not at all cited reasons that included domestic duties, work commitments and organizing study in other subjects. From the data collected by mid-semester questionnaire "extra load", "did not want to attend" were given as reasons for non-attendance at any PASS workshops.

Although PASS leaders did report some initial difficulties in encouraging students to participate actively in workshops, the situation changed quite rapidly as the students came to realize that the workshops

were not tutorials and that the PASS leaders were there to facilitate and guide learning and help students construct their own knowledge. The significant personal and professional growth of the students is ably demonstrated in the consistent and repeated comments by the PASS leaders about the changing group dynamics such as "The group is interacting well with each other now...", "As a whole group, discussion was thrown from one person to another and every one else was involved with their own point of view", and "The interaction of the group increased this week." Some PASS leaders saw real progress towards independence, "The group is really becoming autonomous now".

The irregular attendance at PASS workshops by a small number of students caused problems by disturbing the group dynamics. The focus tended to shift away from the whole group interaction to the 'newcomers' as they explained their concerns while trying to catch up, or indicated that they were ill prepared or that they did not know the ideas and concepts already discussed by the group in previous workshops. Indeed, one student returning after three weeks non-attendance saw the PASS leaders as 'miracle workers' who could provide " ... all the answers" just prior to a mid-semester examination. In this case, the group dynamics were sufficiently well established and stable enough to accommodate the concerns of this student with minimal disruption. Some PASS leaders noted negative changes in group behaviors and dynamics when an academic staff member associated with the administration of the PASS program attended briefly a small number of workshops. The comments from this staff member acknowledged the facilitative role played by the leader, the positive dynamic interactions and the confidence displayed by the leaders. Hence one could assume that the workshops viewed by the staff member were the least effective and that the workshops were implemented according to the philosophy of the program. Nevertheless, the staff leader did note some interactions in which misconceptions in core conceptual knowledge were glossed over without the inaccuracies being identified.

Attention was drawn by the PASS leaders to the increasing cohesion of the groups over time, typified by the growth of students' support and encouragement of each other. The statements "...the group was very supportive of one another, giving encouragement when needed", "Continuously, throughout the workshop, the students swapped and shared notes. One student even wrote up on the board a number of notes which the others didn't have", and "The group have found unity, and they now talk of trying to help everyone pass" are indicative of these changes.

Other comments provided by PASS leaders referred to problems associated with the arrangement of compatible workshop times with students, problems with rooms and learning environments, and concerns about drops in attendance at various points during the semester. A particularly large drop in attendance occurred after the mid-semester examination which alarmed a number of the PASS leaders. Attendance returned to normal about two to three weeks after the examination as pressure of study for the final examination began to build up. PASS leaders' reflections also included comments about their own performance and whether they were handling the duties and tasks of a PASS leader effectively.

An important observation noted by all PASS leaders was the emergence of small, self-help study groups from the PASS workshop groups, observations in accord with previous research on Foundation Science students (Watters *et al.*, 1994). The PASS leaders also recommended that debriefing sessions with the lecturers should be held for students as soon as possible after the completion of major assessment items in order to give them the opportunity to discuss any concerns they might have with the evaluation of their work.

Impact of participation in PASS on grades

The impact on achievement reported on a scale of 1-7 is presented in Table 1. The grade point average (GPA) for the PASS (PG) group is significantly higher than the grade point average for the Non PASS (NOPG) group ($t(121)=4.4$, $p<.01$, 2 tailed). This result should be interpreted with caution as the significant difference between the two groups may not be solely due to the involvement of the PASS Group in the PASS program. Marked differences in grade distributions between the PG and Non PASS Group groups should be noted. There were no failing grades of 1 or 2 among the PG group compared to 5 in the NOPG group. Sixty-six (66%) of the PG group, compared to 28% of the NOPG group, received grades of 5 or better.

Table 1

Impact of participation in PASS initiative on grade distribution and GPA

Group	*n*	1	2	3	4	5	6	7	GPA
PASS Group	59	0	0	0	22	24	11	2	4.88
Non PASS Group	65	1	4	3	39	13	4	1	4.15

In the subsequent semester the students from the Foundation Science course undertook an integrated science, technology and mathematics curriculum course. There is a trend suggesting that those who attended more PASS workshops achieved a higher grade for the science component of the integrated course (e.g. >66% attendance at the PASS sessions (mean 5.4, n=10); 33%-66% PG (mean 4.9%, n=7); <33% PG (mean=4.7, n=11); NOPG (mean 4.6, n=26). However, the mean differences were not statistically different for any of the subgroups at a level of p=.05.

Relationship between self-efficacy, attitudes and participation

Students were administered the STEBI instrument three times: at the commencement of the PASS program, at the conclusion of the PASS program, and at the end of the Science Education unit undertaken in the semester following the PASS program. There was no significant difference between the mean scores of the students who attended or did not attend the PASS program as determined from the pretest administration (Table 2).

Although there were small increases in PSTE during the PASS program for both participants and non participants these were not statistically significant. However, changes in PSTE noted during the Science Education course were significant. In the group who attended most (> 66%) PASS sessions the change in self-efficacy in the sequential Science Education course was significant in a repeated measures ANOVA analysis (F(100,6), 2.45, p=.03). These results suggest that there was no immediate effect on the students' confidence to teach science in the content course, but one could speculate that the enhanced understanding of the content provided a basis for developing confidence in teaching science revealed through the increased self-efficacy scores measured in the following curriculum course.

Table 2

Changes in personal science teaching self efficacy (PSTE)

Level of participation		Foundation Science Pretest PSTE mean (stdev)	Foundation Science Post Test PSTE mean (stdev)	Science Education Post Test PSTE mean (stdev)
None	n=65	43.22 (6.2)	43.95 (6.1)	45.43 (7.2)
< 33%	n=18	44.59 (5.6)	45.57 (5.6)	47.50 (8.5)
33%-66%	n=16	42.56 (7.1)	42.94 (8.2)	45.53 (6.4)
> 66%	n=25	42.0 (6.3)	43.10 (5.2)	47.83 (7.1)*

Note * Significant at p <.05)

Qualitative data did suggest a change in the students own knowledge of science during the Foundation Science course. Of the nineteen students questioned in the mid-semester survey, nine were participants in the PASS program. Comments from eight of the PASS participants were very positive as evident in the statements "Helps to talk to someone who has been through it. Will be a very big help going into the final exam," and "It was extremely helpful. I would have no idea what I need to do without it. I'm confident that I

would have failed my (mid-semester) exam without the PASS group." One respondent who was not a PASS participant indicated that "...I do think they are a good idea and valuable to some people," without further elaboration or explanation.

The PASS leaders reflected on an increase in students' confidence concerning their successful fulfillment of the assessment requirements of the Foundation Science unit and an increased motivation to better prepare themselves for examinations. The following statement is indicative of this observation:

> This preparation (a particular strategy used in a PASS program) was beneficial as it seemed to increase students' confidence in their abilities to complete the exam successfully. As a result of this increase in confidence, it has led to a further increase in motivation with the students being more willing to do more exam preparation.

PASS leaders referred frequently to the anxiety students appeared to be experiencing, particularly when assessment deadlines approached. They related the difficulties and concerns expressed by some students and the resultant impact on their emotional behaviors. One PASS leader described the disturbing effect one student, under obvious distress, had on the functioning of the workshop.

Hence, although the quantitative data did not reveal significant changes in self-efficacy as measured by mean STEBI scores during the Foundation Science course, the qualitative data does suggest that changes in attitudes and confidence towards studying science accompanied participation in the PASS program. A more detailed examination of the STEBI scores showed that some students made substantial positive changes in self-efficacy which was offset by other students whose scores fell significantly, a finding that is consistent with previous observations (Watters, Ginns, Enochs, & Asoko, 1995).

Impact on PASS Leaders

This vanguard group of PASS leaders provided a valuable source of information about the implementation of a SI program. In particular the qualities of these students as leaders can in part be attributed to their particular professional skills as preservice teachers. In addition to the routine PASS leadership training, they had been immersed in educational practice for five semesters including two that focused specifically on science. The selection process sought leaders who were affable, had positive attitudes and a high sense of self-efficacy and already possessed both explicit and tacit understandings of effective learning environments and group facilitation. Although theory and practice rarely merge in preservice programs, this was an opportunity for these students to engage in an authentic educational experience.

The PASS leaders expressed enthusiasm for the program throughout mediated by memories of stress and the need for time management. Motivation to be a leader was driven by three elements: firstly, an altruistic desire to help others through what had been a difficult experience for themselves; secondly, the desire to meet socially and professionally with other students and academics; and thirdly, an overwhelming acknowledgment of the opportunity to develop and implement skills that would be professionally useful.

The program also impacted on PASS leaders as students themselves in two ways. Firstly, the experience of establishing a cooperative learning environment in which critical discourse could occur in a risk-free atmosphere enhanced their confidence and reduced apprehension and stress. Secondly, the technical skills of facilitating a group, questioning, encouraging and scaffolding were acknowledged. On the negative side, there was concern for time management both for themselves and for the students participating in the program.

The experiences and impact of the PASS program were eloquently expressed by Amy whose reflections are quoted below.

> I was originally drawn towards PASS for two reasons; I myself had trouble with Science Foundations when I was a first year student and I wanted to help other students come to terms with the subject. I was also keen to further my professional development and could see that the PASS program offered excellent training opportunities. Even apart from any organized training, being a PASS leader gives you the chance to develop communication and negotiation skills which will be invaluable in both

your personal and professional life. PASS also trains you to deal with stress. In two hours of workshops a week you have to facilitate discussion and help students develop understanding of a whole week's worth of the group's problem areas. Finally, PASS is an excellent way of making new friends with academic staff and other students.

"Helping the students" was harder than I had imagined. At the beginning of PASS (despite all my best intentions to be a facilitator), I was really concerned to ensure that my PASS members studied hard and got "good" (high) marks. Because I was receiving pay for being a PASS leader, I felt that the Faculty could expect a high return for their invested funds. At times, I felt like I had sole responsibility for the success of all my PASS members and I wondered if someone who had struggled with the subject was really qualified to be "helping" others. I was particularly concerned that the members of my PASS group would have lower results than students in other groups because of my inadequacy as a PASS leader. And people say students' parents are too competitive!

As attendance became more regular, the quality of student-student interactions improved. Students directed more questions and statements towards other members and more of these comments were of higher order thinking. These tendencies really reduced my stress levels, allowing me to focus on examining trends of interactions between members and myself. I noticed that the more relaxed I appeared to be, the better the group focused on their learning.

In the third week of PASS I made a concerted effort to stop fretting about attendance numbers and potential GPAs and to concentrate on creating a positive, co-operative learning environment where members could work together to find solutions. I think it was because of this focus that I was able to gain the trust of the shyest member of the group. Originally, this student had extremely low confidence regarding science activities. She was especially loath to participate in discussions or share her log book. Towards the end of PASS, she suggested that we use concrete materials to help us visualize difficult concepts, encouraged others to attend regularly, and even asked to borrow measuring apparatus so she could practise her skills at home.

The biggest problem I faced during PASS was group members' regular pleas to be "told the answer". Students in subjects with high failure rates are often so frightened of being "wrong" that they are not prepared to chance answering questions. That's why PASS is so successful. In PASS workshops, students are working with their peers. Students become part of a solutions-oriented learning network. The PASS leader sometimes has to work consistently to maintain this balance. It is hard to keep redirecting answers when students are so focused on black and white answers but sometimes the best thing you can do for a student is say "No, I won't tell you. You come back next week and tell me." Students should also be encouraged to dispute each others' answers and ideas, because this encourages deep thought, abstraction of ideas and familiarity with course materials.

PASS is magical because it forces students to find their own solutions instead of accepting the solutions of someone else. Whether or not PASS is successful in terms of improving individual student grades or year level GPAs, there is no doubt that the PASS program promotes and nurtures individual thought. It is not the aim of PASS to teach students, but to encourage them to learn.

For new PASS Leaders: You should expect that the format of PASS workshops will change according to the group dynamics, and remain flexible. At the beginning of the semester, you may need to plan some ice breaking activities, but as the group develops, very little planning will be required. Group members are becoming autonomous learners. Try to encourage members to identify their strengths and weaknesses so the group can operate effectively. Don't be afraid to tell the group about your weaknesses, and refer them to another PASS leader, tutor or lecturer for help with that aspect of the course.

Don't feel disheartened if your initial student turn-out is low. You can:

- alter your approach
- encourage members to "bring a friend"
- advertise around campus
- consult with your co-ordinator

Make sure you network with other PASS leaders.

Advice for lecturers who haven't participated in the PASS program: You should try to avoid solely theoretical discussions in new, difficult areas and have the courage to elicit and accept student feedback. It will improve students' attitudes towards you and the subject, maximizing student success.

Do try to be approachable and smile at students occasionally! Make sure you publicize PASS and explain it to students regularly. It will lighten your work load. Introduce your PASS leaders and allow them to speak to the group so students aren't shy about approaching them.

Similar feelings and counsel were expressed by all the other PASS leaders.

Conclusions

A review of quantitative data in the form of final grades in the Foundation Science course reveals that the overall performance of the group of students who attended PASS workshops was significantly better than the overall performance of the remainder. The grade point average for the PASS group of students was significantly higher than the grade point average for the group of students who did not attend PASS. It may be inappropriate to ascribe completely this significant difference to the involvement of the relevant group of students in the PASS program, however, the value of the intervention, in terms of changed attitudes and behaviors, is clearly evident in the qualitative data.

There was no significant change in science teaching self-efficacy during the Foundation Science course, as measured by STEBI-B, for the group of students who participated in the PASS program. A similar observation can be made for the group who did not participate in the PASS program. This result is in accord with other studies, which employed interventions such as counseling strategies, with first year elementary teacher education students (Watters & Ginns, 1995; Watters *et al.*, 1995). However, there was a change for greater-than-67%-attendance group over the Science Education course.

The qualitative data suggest that there are positive changes in students' attitudes to science. These data indicate that students' personal beliefs about science, reflected in their attitudes to science, are changing for the better, however, their personal beliefs about their ability to teach science and that good science teaching can be effective are remaining constant. The data also indicate that students' thinking and learning strategies have changed as a result of involvement in the PASS program and that they have adopted more autonomous and reflective practices. The level of group interaction and personal support for each other, as individuals, underwent important positive changes during the semester with increased cohesiveness being noted by the PASS leaders. Many students initiated the formation of self-help study groups, while maintaining attendance at PASS workshops. This particular outcome is similar to that noted by Watters *et al.* (1994) resulting from a counseling strategies intervention. In conclusion, the qualitative data indicate a positive and beneficial impact of the PASS program on participating students and on the personal and professional development of the PASS leaders.

Implications

Supplemental instruction, peer teaching, reciprocal teaching are practices that involve students who have begun to move towards a culture of practice in enculturing neophytes. The third year students in this study provided insights to the culture of practice for the first year students participating in the PASS program. When the formal knowledge is indexed to the culture, learning becomes situated. Ideally peer tutors should promote learning by explicitly modeling their own knowledge in context, and modeling their own learning strategies. Additionally, the tutors should attempt to develop self-regulatory strategies in the students (Schunk & Zimmerman, 1994). Peer tutors can arouse students affectively by encouraging them to value competence and to engage in positive self-evaluation. They facilitate the processes underpinning students' goal setting, planning and performance (McCombs, 1989).

In the implementation of any innovation that purports to improve student performance and achievement the process needs to be clearly defined and its verisimilitude established. The students in this innovation were trained and were receptive to the general intent of the training which was to provide facilitatory help. They were not grounded in theoretical assumptions of what would or should work and were not given guidance on the crucial element in peer tutoring namely the role of questions, explanations and the discourse of inquiry that encourages learners to engage in deep thinking. In the absence of explicit training the development of interactional styles that allow peers to engage in elaboration of ideas, explanation and argument peer learning may be problematic (Kohler & Greenwood, 1990; Webb, 1989). Nevertheless, the

innovation did appear to be successful and has the potential to be even more effective if strategies that facilitate deeper thinking and implemented.

Cognitive apprenticeship (Collins *et al.*, 1989) tries to enculture students into authentic practices through activity and social interaction in a way similar to a craft apprenticeship. The peer tutors should be coaches who model and provide scaffolding for the beginning students within a social context. As the beginning students gain more self-confidence and control they move into a more autonomous phase of collaborative and social learning. The social network contributed by developing the language and grounding the conceptual and procedural knowledge in a common culture of practice. Ideas are exchanged, belief systems modified and a common goal or community of learners is developed. The tutors progressively withdraw support as the students become more encultured, self-regulated and autonomous.

In conclusion, the PASS leaders in this situation demonstrated extraordinary skills in authentic settings thus providing convincing evidence that they have achieved leadership qualities. In retrospect these leaders displayed very high motivational characteristics. They took risks, they accepted the challenge of further demands on their time, but nevertheless retained a sense of humor and an allegiance towards the program that was a model of inspiration.

The remaining challenge is to increase the participation of Foundation Science undergraduate students in the PASS program. Although substantial gains in achievement scores were observed, at what cost was this achieved, and will these gains hold throughout the undergraduate program? More research needs to be undertaken on those students who do not participate. What are the motivations of these students who, despite the obvious advantages of participation in PASS, do not participate? One suspects that time constraints and affective components are at the forefront of these students' reluctance to engage.

Peer assisted learning implemented on an SI model has been an effective initiative. Student achievement has been enhanced as measured by GPA. While many factors affect self-efficacy, involvement in the PASS program appears to be one initiative that improves a students' sense of self-efficacy in the longer term, possibly because of the increased confidence the students have in their own knowledge of science. Important skills are also developed by leaders. Initially, they played a major role in encouraging discussion, providing strategies, coaching and modeling processes required to be successful in the unit. As time progressed the leaders were able to fade from their "dominant" role and allow autonomy to develop — a genuine implementation of scaffolding in a Vygotskian sense.

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